Exercise 1.3-2

Derive numbers for v_0, v_D, τ, and l

- Show that the claims made in the backbone text are actually true (for room temperature = **300 K**). Use the following equations taken from the backbone
  - For the average velocity v_0 of a particle zooming around in the crystal:

$$v_0 = \left(\frac{3kT}{m}\right)^{1/2}$$

  - For the mean time τ between scattering:

$$\tau = \frac{\sigma \cdot m}{n \cdot e^2}$$

  - For the drift velocity v_D

$$v_D = -\frac{E \cdot e \cdot \tau}{m}$$

  - For the minimal mean free path length l_{min} obtained for $v_D = 0$:

$$l_{min} = 2 \cdot v_0 \cdot \tau$$

- Of course, you need numbers for the concentration n of the free carriers and for the specific conductivity σ
  - Since we are essentially considering metals, you assume for a start that you have **1** free electron per atom if you want to find a number for n. Here are a few data needed for the calculation:

Atom	Density [kg · m^{-3}]	Atomic weight × 1,66 · 10^{-27} kg	Conductivity σ × 10^5 [Ω^{-1} · m^{-1}]	Conzentration Atoms n [m^{-3}] ???
Na	970	23	2.4	
Cu	8.920	64	5.9	
Au	19.300	197	4.5	

- You may run into some trouble with the dimensions. Just look at conversions from, e.g. **[eV]** to **[J]**, from Ω to **V** and **A**, and at the relations beween Volt, Ampere, Watts and Joule.

Solution